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AUTHOR Huang, Chu-Ren
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ABSTRACT

The paper explores the significance of a contrast between generalized phrase structure grammar (GPSG), a context-free grammar with a well structured theory of features, and head-driven phrase structure grammar (HPSG), a mechanism for increasing the power of GPSG by introducing head-wrapping and lexical rules, using examples from Mandarin Chinese. A study focusing on the discontinuous idiom chunks of possessive object (POBJ) construction produced the unexpected result that even though head-wrapping is a syntactic operation introduced to account for discontinuous constituencies, POBJ data cannot be accounted for with the Head-wrap mechanisms. The adoption of Head-wrap operations as the only explanation of discontinuous constituencies predicts that one of the disjoint sub-strings must have the head of the entire constituent on its edge. The validity of Head-wrap as the mechanism for accounting for the discontinuity of syntax is challenged by the fact that the frequency/duration adverbial splits the POBJ predicate non-adjacent to the head. The failure of grammars with head-wrapping to produce a straightforward syntactic solution to the POBJ data calls for a closer examination of non-syntactic approaches. (MSE)

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Chu-Ren Huang

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IS HEAD-WRAP NECESSARY?
MANDARIN POSSESSIVE OBJECTS IN GPSG AND HPSG*

Chu-Ren Huang
Academia Sinica and Tsing Hua University

Among recently developed unification-based grammatical theories (Shieber 1986), there is a genetically related pair offering interesting contrasts. GPSG (Generalized Phrase Structure Grammar, Gazdar et al. 1985) is a context-free grammar with a well-strucutred and powerful theory of features. HPSG (Head-driven Phrase Structure Grammar, Pollard 1984, and Sag and Pollard 1987), while maintaining the important characteristic of being recognizable in deterministic polynominal time, increases the power of GPSG by introducing head-wrapping and lexical rules.1 The innovations allow the grammar to do without metarules (Pollard 1985), and to account for discontinuous constituencies in a more straightforward way.2 More specifically, with head-wrapping, and the notion and notation of Head as a grammatical primitive, a string can be inserted within another string in HPSG.3 That is, in a headed string (a string where the head is marked), head-wrappping renders the positions immediately before and after the head accessible to syntactic operations.4 Since the constituency of the original string has not been changed, the fact that two disjoint sub-strings form a constituent can be accounted for without referring to any contextual information other than what is encoded on the headed string. As a consequence, an interesting contrast occurs between HPSG and GPSG with regard to discontinuous constituencies. The contrast is that HPSG has head-wrap as one powerful and coherent mechanism to account for such constructions, while GPSG needs some ad hoc measures.

In this paper, I try to explore the significance of this contrast by studying a set of Mandarin Chinese data. Mandarin grammatalizes very little dependencies and shows even less of them with overt markings.5 In other words, for discontinuous constituencies in this language, the discontinuity is likely the only non-cannonical syntactic fact to be accounted for. A reasonable speculation is that they serve as ideal cases demonstrating the advantage of head-wrap mechsanisms. This paper focuses on one such case, the POBJ (Possessive Object) construction.

I) The Data and a GPSG Account

The POBJ construction (underlined in 1) is a set of discontinuous idiom chunks. The construction is so-called because it shares the same surface structure with the possessive construction. Thus 2 is ambiguous with two readings: the more readily available POBJ reading a and the genuine possessive reading b.

(1)a. ta sheng le Wangwu san ge zhongtou
s/he give-brith PERF Wangwu three MEASURE hour
(de) qi
DE air
b. ta sheng le san ge zhongtou Wangwu
s/he give-brith PERF three MEASURE hour Wangwu
(de) qi
DE air
'S/he was mad at Wangwu for three hours.'

(2) Zhangsan chi Lisi de cu
Zhangsan eat Lisi DEnp vinegar
a. Zhangsan is jealous of Lisi.
b. Zhangsan uses Lisi's vinegar.

Like transitive verbs, a POBJ predicate takes two arguments. Unlike typical transitive verbs, its non-subject argument, as well as duration/frequency adjuncts, can only occupy positions between two parts of the discontinuous constituent.

Referring to the first noun phrase in the POBJ string [verb NP (de) NP] as NP1 and the second as NP2, Huang's (1987. ch.4) summary of the grammatical features of the POBJ construction is repeated in 3. The features relavent to the discussions on head-wrapping are the first two and the distribution of frequency/duration adverbials described in 1.

(3) a. The matrix verb forms a (discontinuous) idiom chunk with NP2.
b. NP1 is the oblique object of the idiom chunk.6
c. NP1 allows wh-questions and anaphora, but cannot be topicalized.
d. NP2 allows neither wh-questions, nor anaphora, nor topicalization.
e. A reflexive pronoun in the NP1 position can be coreferential with the matrix subject, while a non-reflexive pronoun cannot.

The following GPSG account is proposed in Huang (1987.258-265). His analyses make crucial uses of two mechanisms of the theory: metarules and feature matrixes.

Based on the observation that Mandarin Chinese allows an adverbial phrase to occur between a verb and an object, exemplified by 4, the ID/LP statements in 5 and 6 are proposed.7

(4)a. ta kanle sange zhongtou shu
s/he read-PERF three-MEASURE hour book
'S/He has been reading books for three hours.'
b. *ta kanle shu sange zhongtou
s/he read-PERF book three-MEASURE hour

(5)8 ID Rule: VP --> H, XP[+ADV, +DUR/FRE], NP

(6) LP Statements:
   a. H[+V, -N] < [BAR 2]
   b. [+ADV] < [-OBL]

Since the adverbial phrase is a modifier of the verb phrase, Huang (1987) treats it as a sister of the verbal head in 5. The LP statement 6a postulates that the lexical head precede other phrasal sisters and 6b that an adverbial phrase precede a non-oblique noun phrase. He also notices that the oblique object (NP1) in a POBJ construction occurs either before or after the adverbial, and that the idiom chunk object (NP2) and object NPs in other constructions, such as the object in 4, must occur after the adverbial. Thus he assumes that the LP statement specifically refers to the feature [-OBL].

(7) VP[POBJ] --> W

VP[POBJ] --> W, NP[+OBL]

(8)a. Sanbai chi Yunniang de cu
      Sanbai eat Yunniang DE vinegar
      'Sanbai is jealous of Yunniang.'
   b. Sanbai chi cu
      Sanbai eat vinegar
      'Sanbai is jealous.'

The metarule in 7 is the cornerstone of the proposed account. The input of the metarule is a ID statement independently motivated by 8b. It does not differ from other VP rules except that the head is marked by the feature [POBJ], which Huang (1987) assumes to be a subcategorization feature marking all POBJ idiom chunks. The metarule takes such ID rules and gives back ID rules with an extra argument: an oblique object, as exemplified by 9.

(9) VP[POBJ] --> H, NP, [+ADV, +FRE/DUR], NP+[OBL]

(10)9 [+OBL] < [-OBL]

The output ID rule 9 is governed by the LP statements in 6. 6a postulates that the lexical head in an ID rule precede all other phrasal categories. Thus in the POBJ construction the verb is the first element in the VP. The LP statement 6b requires a non-oblique NP to follow an adverbial, and the additional LP statement 10 requires it to follow the oblique object. Thus the fact that NP2 is the last element in a POBJ verb phrase is accounted for. The alternative order between the adverbial phrase and NP1 is predicted by the grammar because there is no LP statement governing the order between an oblique NP and an adverbial phrase.10

The analysis just sketched has two problems. the first involves semantics and the second constituent struc-

tures. Both suggest inadequacy of this GPSG account. First, the meanings of the idiom chunks are not compositional. They are each instantiated on two segments: the verb and NP2, but do not equal the logical sums of the meanings of the (two) segments. One strategy is to give each idiom chunk a lexical entry which specifies the semantic meaning and the two segments involved. For such a strategy to work, the two segments must either be retrieved as a unit directly from the lexicon or be linked to the same piece of information in the lexicon, even though they occur discontinuously without sharing a local tree. The proposed rules for the POBJ construction admit a tree where the verb and NP2 are not adjacent to each other. Thus they cannot form a single lexical item.11 Since GPSG does not allow syntactic operations to reach beyond the domain of a local tree, neither is it possible to relate the two segments to one lexical entry. The general translation schema in Gazdar et al. (1985) fails to derive a correct semantic translation for 9.

Second, instead of forming a constituent, the nodes in the string [NP1 de NP2] are analyzed as sisters of the verbal head in this account, contradicting evidence cited in Huang (1987. ch.4) showing that they form a constituent. A dilemma arises between conserving a direct mapping from syntax to semantics and representing the configurational information. The analysis assigns the flat structure 9, in which the adjunct is a sister of the head of the predicate, such that it can be directly translated as a function taking the predicate as an argument. Assigning the structure [np NP1 de NP2] would include the duration/frequency adverbial in the same noun phrase. The adjunct would be a sister of both NP's but not the verb. Direct mapping between syntax and semantics can only interprete the adverbial as semantically interacting with either NP1 or NP2.12

II) An HPSG Analysis

HPSG differs critically from GPSG in that it allows non-adjacent surface segments to form a syntactic unit. This is done by introducing head-wrap, in addition to the familiar concatenation operations, as a mechanism to form larger syntactic units.13 The reference to Head comes from the fact that strings can only be segmented immediately before or after the head of that string. `Wrap' refers to the fact that one argument, i.e. one of the strings, `wrap' around the other argument. Various concatenation mechanisms are also included in the grammar.

(11) LL1(Left-left Head Wrap 1):
`Wrap the left hand argument around the other argument, placing the head of the former immediately to the left of the latter, and take the head of the first argument as the head of the resultant string.'

(12) LL1<S,T> = s1 ....si t1 .. tj ... tm s(i+1) ... sn
                        * <--head
where S = (s, i) = s1 ... si ...sn
                           *
and T = (t, j) = ti ...tj ... tm
                      *

11 and 12 exemplify the Head-wrap rules. Other rules can be constructed along the same line. The rule, called 'left-left head wrap 1,' is described in 11 and formulated in 12, following Pollard (1984). In 12, again following Pollard's (1984) convention, an asterisk marks the head of a string. Capital letters S and T stand for strings, and subscripted small letter si and ti stands for elements in the string. The number i in the ordered pair (s, i) designates the position of the head in the string. The LL-1 rule in 12 places the second argument immediately to the right of the head of the first argument which also serves as the head of the new string. It should not be difficult to envisage the idiom chunk [verb ... NP2] involved in a POBJ construction as the first string and the wrapping element, and the oblique object the second string, i.e. the wrapped argument. LL-1 would give the exact order needed for the combined string.

(13) <VP[POBJ] --> LL1(VP[POBJ], NP); FA>
where VP[[POBJ] --> H NP[POBJ]
                      *

13 spells out the details of the LL-1 operation applied on the idiom chunk rule and the oblique object NP to generate the POBJ construction. In this analysis, the order between the verb, NP1, and NP2 is correctly captured. The fact that the verb and NP2 form a semantic unit, a predicate, and that NP2 is an argument of that predicate is also captured with the help of the head-wrap mechanism. FA stands for functional application. Thus the semantic translation of the POBJ construction is simply applying the function represented by the wrapping idiom chunk to the nominal argument represented by NP1. The potential problem of semantic translation that arises in the GPSG analysis is solved.

(14)a. Sanbai sheng-le Yunniang bantian de qi
Sanbai give-birth-PERF Yunniang half-day DEnp air
b. Sanbai sheng-le bantian Yunniang de qi
Sanbai give-birth-PERF half-day Yunniang DEnp air
'Sanbai is angry at Yunniang for a long time.'

Rather unexpectedly, this head-wrapping account still has problems with the placement of one of the adverbial positions. In 14, it is shown that duration/frequency adverbials have two possible positions in a POBJ construction. Since an adverbial phrase semantically takes the

whole predicate as its argument, i.e. it modifies the whole predicate; syntactically, it and the whole POBJ predicate, i.e., the output string of 13, should be two arguments of the same operation. The problem is that Head-wrap operations can only wrap an argument immediately next to the head. This allows us to derive 14b but not 14a. 15a is the right-left head wrap rule accounting for 14b. 15b gives the resultant headed-string.

(15)a. <VP --> RL2 ([+ADV, +FRE/DUR], VP[POBJ]; FA>
b. VP --> H XP[+ADV, +FRE/DUR] NP[OBL] NP
*

Given the position of the adverbials in 14a, there is simply no Head-wap rule available to generate the correct string. Given the strictly order nature of the CON feature Pollard (1984) adopts, neither does it seem possible to allow adjunts to be combined with the predicate before the oblique object to get the rightr order.14 Thus, the idiosyncracy of this construction cannot be accounted for with Head-wrap rules in the framework of Pollard (1984).15

III) Idioms as Partially Defined Functions: A Solution

The failure of grammars with Head-wrapping to produce a straightforward syntactic sulotion to the POBJ data calls for a closer examination of non-sytactic approaches. Although it does not seem possible for GPSG to account for the discontinuous constituency of POBJ in syntax without mechanisms to permutate elements within a constituent, there is no reason to preclude a lexico-semantic account. Wasow et al. (1983) propses a brilliant account for some English idiom chunks. The basic idea is that elements in idiom chunks should be treated as compositional. Traditionally, it has been taken for granted that idioms are not compositional in the sense that the meaning of an idiom cannot be derived compositionally from the literal meanings of their components. But pieces in an idiom do have identifiable meanings and often allow internal modification or show syntactic versatility. Thus they could be treated compositionally by assigning special meanings to them and by restricting the applicability of these meanings. In general, these idiomatic meanings would be treated as partially defined functions. For example, the idiomatic intension of take (as in take advantage of) would be a function which is defined only on the idiomatic intension of advantage. Following their lead, I will assume that the semantic meaning of the POBJ construction is derived compositionally from the meanings of the verb and NP2. For the idiom sheng..qi 'be mad at', the intension of sheng would be a function which is defined only on the intension of qi. An assumption specific to this Mandarin construction is that the nominal category (eg. qi 'air') of the idiom chunk syntactically encodes the subcategorization information and is semantically translated as

a function which takes two arguments. This assumption fits in nicely with Chierchia's (1982, and 1984) IL*, the semantic framework I am adopting here. On the other hand, the verbal head (sheng) is translated as a partially defined identity map, and the adjunct is marked with a semantically potent feature which allows it to be interpreted at the correct level. Together with appropriate LP statements, the rules 16-18 account for POBJ in GPSG.

(16)a. VP[POBJ] --> H, NP[POBJ]; <H' (NP')>
b. NP[POBJ] -->NP, (ADV[D/F]), (de), N[POBJ];
<lamda V'[(ADV'(V'[N'(NP')])]>

(17) qi, N[POBJ], lamday lamdax [BE-MAD-AT (x)] (y)

(18) sheng, V, <lamdaP P>,
where P is a type <e,p> variable
[type <<e,p>,<e,p>>, restricted identity map, defined only on the lexical item qi of 17]

This solution, suggested to me by Gennaro Chierchia (p.c.), allows [NP1 (de) NP2] to form a constituent. Is is not unlike the LFG account proposed in C. Huang (1987. ch.4). In that account, POBJ constructions are treated as double-headed constructions, and both the verb and NP2 are partial instantiations of the predicate. In this account, NP2 alone bears the subcategorization information, and the verb preserves that information as an identity map. Assuming the ID rules of 16, the lexical entries for the two discontinuous parts of the idiom chunks would be given as 17 and 18.

(19) cu, N[POBJ], lamy lamx [BE-JEALOUS-OF (x)] (y)

(20) chi, V, <lamP P>, where P is a type <e,p> variable,
[type <<e,p>,<e,p>>, restricted identity map]

19 and 20 account for another discontinuous idiom chunk chi...cu 'be jealous of' and illustrate an advantage of the current analysis. 19 is the lexical entry for cu as NP2. It is simply a two-place predicate. Since the GPSG semantics is type-driven, 19 entails that NP2, cu in this case, would take NP1 as an argument with straightforward functional application. The limited space of this paper does not allow detailed explication of the semantic account. Briefly, I simply assume that when an adverbial is present, the translation relies on the feature system. A semantically motivated feature will be employed to mark that the adverbial is modifying the whole VP rather than the POBJ NP. Recall that semantically potent features are translated in semantics in GPSG. Similar to the treatment I gave to the DEnp-construction with object gaps in chapter 3 of Huang (1987), the translation of this feature would allow the meaning of the adverbial to be introduced

at the VP level. The verb would be assigned a translation of a type <<e,p>, <e,p>> identity map. Such special translations would be defined for those idiom chunks only. That is, chi would be a partial function defined for the few lexical items it co-occurs with as parts of idiom chunks, like cu, bingqilin 'ice cream' [chi bingqilin 'take advantage of']. This move is supported by limited productivity of the idiom chunks.

(21)a. chi cu (vinegar) 'be jealous at'
b. chi bingqilin (ice cream) 'take advantage of'
c. chi fan (rice) 'be employed by'
d. chi kuei (deficit) 'be taken advantage of'

In 21, I show that the verb chi 'eat' recurs in some idioms. It would be desirable to anlyze all the occurrences of chi in these idioms as the same lexical item. The partial function of identity map seems to be an answer. It implies that it is NP2 which dictates the meaning of the idiom, as predicted by my lexico-semantic analysis.

IV) Conclusion

This paper studies the discontinuous idiom chunks of the POBJ construction with a somewhat unexpected result. Even though Head-wrapping is a syntactic operation introduced primarily to account for discontinuous constituencies, the POBJ data cannot be readily accounted for with the Head-wrap mechanisms. The adoption of Head-wrap operations as the sole explanation of discontinuous constituencies predicts that one of the disjoint sub-strings must have the head of the whole constituent on its edge. The POBJ data, exemplified in 14a, offer an exception to this prediction. The frequency/duration adverbial splits the POBJ predicate at a position non-adjacent to the head. Such a fact casts doubts on the validity of Head-wrap as the mechanism to account for discontinuity on syntax. I have also shown that a lexico-semantic analysis adopting Wasow et al.'s (1983) idea accounts for the data. Head gramamr, as formulated in Pollard (1984), however, cannot adopt this solution easily. The strict partial order encoded in the feature values of the CON feature does not allow the semantic manipulations required by this lexical analysis. There are two possible interpretations of the current study. One can take the POBJ data as evidence showing that Head-wrap mechanisms simply do not correctly characterize the set of discontinuous constituencies allowed in natural languages. Alternatively, one can also argue that the set of data discussed illustrate lexically-controlled discontinuencies, while Head-wrap rules should satisfactorily accounts for syntactic discontinuencies. The choice of a correct interpretation awaits further studies of discontinuous constintuencies in other natural languages.

FOOTNOTES

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1 Strictly speaking, the grammar introduced in Pollard (1984) is called Head Grammar by him. HPSG refers to a later version developed at Hewett-Packard and partially documented in Pollard (1985) and Sag and Pollard (1987). One substantial difference is that HPSG has a much richer lexicon. Since this paper deals mainly with the Head-wrap operations shared by both grammars, I will not differentiate them.

2 The best known example of discontinuous constituency is the Dutch cross-serial dependencies discussed in Bresnan et al. (1982). It is argued that GPSG cannot assign the correct structure to this construction. Grammars with Head-wrapping, on the other hand, offers a relatively simple account (Pollard 1984, Sag et al. 1986).

3 See the definition of a head grammar in chapter 1 of Pollard (1984). See also the appendix there for mathematical properties of the grammar. The mathematical properties of HPSG are not yet fully understood. My discussions will be restricted to the features it shares with head grammars.

4 Similarly, one can perceive concatenation as marking the positions immediately after the last element of the string and before the first element of the string for another string.

5 The language has no morphological case, nor tense, nor agreement. It has topicalization as an instance of long distance dependency, but has no gapped wh-questions.

6 NP1 is an oblique object in the sense that it is a structurally marked argument (though not morphologically marked) which is the only argument other than the subject but does not behave like a typical object. Supporting evidence includes the facts that it does not occur in the Mandarin passive construction, and bei-construction. See Huang (1987, ch.4) for detailed discussion.

7 Both 5 and 6 are slightly revised . XP in 5 needs to be further restricted, maybe to [+N, -PRD].

8 A problematic case, pointed out to me by Louie Mangione (p.c.), is given in (i). In (i), the frequency of occurrence adverbial occurs after the object. This phenomenon is allowed with certain verbs only. For exam-

ple, 3b with an identical structure is ungrammatical. I do not have a straightforward account for (i) for the moment. Another observation is that (i) is another counterexample to J. Huang's (1982) Phrase Structure constraint. Adopting a strictly bi-branching phrase structure schema, as J. Huang (1982) does, the VP would have to be left-branching twice because both the NP complement and the NP adverbial occur to the right of the verb.

(i) ta qu-guo meiguo sanci
s/he go-EXPERIENCE America three-times
'S/He has been to America three times.'

9 A more general way to capture the effects of this LP statement is (i). Since the idiomatic feature of NP2 has to be specified, (i) guarantees that NP2 is preceded by all its phrasal sisters, including the adverbials. The domain of this statement overlaps with 10. Further studies will determine between the overlapping rules.

(i) XP < NP[IDIOM]

10 The occurrence of the optional DEnp is not discussed here and is assumed to be accounted for by the general schema in chapter 2 of Huang(1987).

11 The semantics of GPSG, as explained in Gazdar et al. (1985.182-244), is a tree interpretation procedure. The translation rules take trees as inputs and return intensional logic translations as outputs. The verb and NP2 are clearly not adjacent on the tree and are not even on the same local tree. Thus they cannot be translated as a unit.

12 Another point worth noting is that explicit reference to grammatical relation is made in the LP statement in 6b. It is generally conceived unnecessary to refer to grammatical relations in GPSG though the proposed mechanisms do not preclude such a possibility. The data show that it is crucial to differentiate NP1 from NP2 to get the right order, and that NP2 has to pattern with other object NPs in being ordered after the adverbial phrase. The only grammatical feature distinguishing NP1 from other NPs is that it is an oblique object and the others are not.

13 It is worth bearing in mind that head-wrap cannot scramble a string, such as transformations do. In addition to the positions before and after an category (a headed-string in HPSG), it allows the other category to occur in two positions within the stirng representing the wrapping category, one immediatly before and one immediately after the head of that string.

14 In Pollard (1984), the CON (mnemonic for control types) feature, similar to the definition of categories in Categorial Grammar, stipulates how arguments are combined with argument-taking predicates both syntactically and semantically. For instance, the familiar [CON TRN] (for TRNsitive VP) category will take an NP argument syntactically, paired with the semantic operation of functional application, to form a [CON INT] [for INTransitive VP]

category. Similarly, together with the semantic operation of Equi adopted in GPSG, a [CON OEQ] (for Object EQui) category will combine with an NP syntactically to form a [CON TRN] category. There is a strict partial order relation among these control types. As Pollard (1984) himself observes, optional arguments cannot be easily incorporated in this system. Head-wrapping would have yielded the correct linear order for 14a if the optional adverbial phrase were 'wrapped' before the oblique object (i.e., a rule like 15 is applied before 13). But then the semantic type and the CON feature of the adverbial phrase cannot be uniquely determined in the grammar as defined in Pollard (1984). He notices in a footnote that adjuncts can be easily accounted for in his grammar if predicative heads are translated as denoting relations among quantifiers of situations. In this appraoch, the frequency/duration adverbials, as adjuncts, could be combined with the predicate before or after the oblique object without affecting its semantic translation. This proposal, however, has not been fully formalized and cannot be justly evaluated here.

15 Pollard (1984) does incorporate uses of linear precedence statements to determine the ordering of complements in constructions such as the anomalous raising constructions. Thus he introdueces a third type of syntactic operation AL (for anomalous linearization). The definition is quoted here as (i), where Mi stands for headed-strings and Xi stands for corresponding categories.

(i) AL(<M0, X0>, <M1, X1>, <M2, X2>)=
(M0 Mj Mk: <j, k> is a permutation of <1, 2> such that <Xi, Xj> is consistent with the LP rules [in the grammar].)

Pollard (1984) calls Head Grammars with the AL mechanisms Extended Head Grammars and argues that they have the same weak gerative capacity as Head Grammars. AL, however, cannot be applied to account for the POBJ data in 14a. Linearization can only take place among headed-strings which are instantiations of syntactic complements (i.e. required arguments in his terminology). The order relation needs to be captured here involves NP2, a non-head segment of a headed-string and a non-argument.

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